I. C. 7305

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BUREAU OF MINES
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INFORMATION CIRCULAR

SUCCESSFUL METHOD FOR SIGNALING FROM MINE CAGES AT REST OR IN MOTION

BY

CARL BELSER

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UNTIED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

SUCCESSFUL SYSTEM FOR SIGNALING FROM MINE CAGES AT REST OR IN MOTION[1]

By Carl Belser[2]

In 1925 the Park Utah Consolidated Mines Co., after several years of experimental work, installed a system for signaling from cages which has been operating efficiently and with low upkeep costs for the past 19 years. The system was adopted for a large western metal mine but was later abandoned because of the constantly shifting shaft alinement. Recently the system has been studied and probably will be put into service at two other large mines. One of the principal reasons why the system has not been adopted more widely has been the lack of adequate details both as to the desirability of having such a system and as to its construction and operation.

Previous signaling systems contained undesirable features, such as charged bare wires extending the full length of the shaft. Under the direction of O. M. Friendly, then general superintendent of the Judge Mining & Smelting Co., the present system, entailing the use of a samll current at low voltage, was gradually developed. Many of the refinements in the system were contributed by Leonard Wilson, consulting electrical engineer, Salt Lake City, Utah.

Information Circular 6161, Signaling from Cages at Rest or in Motion, admirably describes the Park Utah system and is here quoted in part.

[3]/Signaling the hoisting engineer at shaft and slope mines is an important feature in safe and efficient haulage or hoisting and is a feature rarely considered in mine-hoisting installations; there should be at least two, preferably three, independent signaling systems, and there should by all means be a signaling system operable from cages whether moving or at rest. Such a system may be fully as economical as the usual systems operable only from the levels, and in some instances the signaling from the cage can be made more economical than a similar system of level signaling. The outstanding feature of the method allowing of signaling from the cage is its greater safety; however, the greater and more positive control of hoisting may easily effect economies that will offset the cost of the installation.

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgement is used: "Reprinted from Bureau of Mines Information Circular 7305."

2/ Mining engineer, Bureau of Mines, Salt Lake City, Utah.

3/ Parker, I. J., and Manning, R. I. C., Signaling from Cages at Rest or in Motion: Bureau of Mines Inf. Circ. 6161, 1929, 7 pp.; page 6, para. 4 and 5.

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The cost is trivial when prevention of accidents or the saving of human life is considered. Nevertheless, the cost of one severe accident or of one life lost through the failure to provide a signal on the cage will more than equal, in cold cash expended in compensation, the cost of the installation or its maintenance and operation for several years. Many instances could be cited of lives lost or jeopardized, particularly in coal mines, by lowering men into water-filled sumps; innumerable accidents and deaths have occurred during the ordinary working periods due to the necessity of signaling from the level and afterwards walking or running to the cage, or of reaching out from the cage to signal from some fixed point on the level; lack of ability to signal from the moving cage during ordinary working time has resulted in numerous accidents; many resulting in death and many others in heavy destruction of property. The ability to signal from a moving cage during shaft fires in metal mines is a safety feature which in itself should require its universal use; many such fires when first discovered could be extinguished, if men could control the moving cage by definite signals.

4/ The Park Utah Consolidated Mining Co. has two systems of signaling from moving cages in three of its mines; both systems are reported to be successful and satisfactory; but they required years of experimentation before reaching their present successful workable state. The Park Utah Consolidated Mining Co. is probably the only company in the United States using this type of shaft-signaling in connection with the ordinary types of cages and skips, though in some shafts men and certain kinds of materi are carried by elevators of the office-building type and having the usual ability to start and stop at any point in the shaft.

The installations at the Daly West and the Daly Judge shafts are similar. Both shafts are exceptionally wet, but this condition has not prevented the successful operation of the signaling system. The Daly Wes shaft is 2,200 feet deep. Details of the system for movement of men and supplies on cages used in these two mines are shown in figure 1. A two-naught (00) trolley wire, suspended in the shaft, is secured by hangers placed 10 feet apart; the lower end is below the last station. The upper end of the trolley wire is connected to a 150-ohm Bonnell relay, B, which in turn is grounded to the hoist. An Edison 3-cell, 6-volt storage batte C, is placed in a weatherproof box securely fastened to the outside of th cage. One battery terminal is grounded to the cage and the other termina is connected to the pull switch, D, which when operated forces a steel pantograph against the trolley wire. The circuit through the relay is co pleted and closes the circuit in a 110-volt alternating-current line, rin ing a signal-stroke 10-inch bell, A. A lamp directly above the bell also lights when the circuit is closed.

5/ The rotary pull switch, D, on the cage is provided with a shaft wh can be rotated from each of the two decks of the cage. When the switch cable is pulled, the shaft is rotated, and contact with three finger spri

4/ Work cited in footnote 3, p. 4, par. 4 and 5.
5/ Work cited in footnote 3, p. 5, par. 1,2,3, and part of 4.

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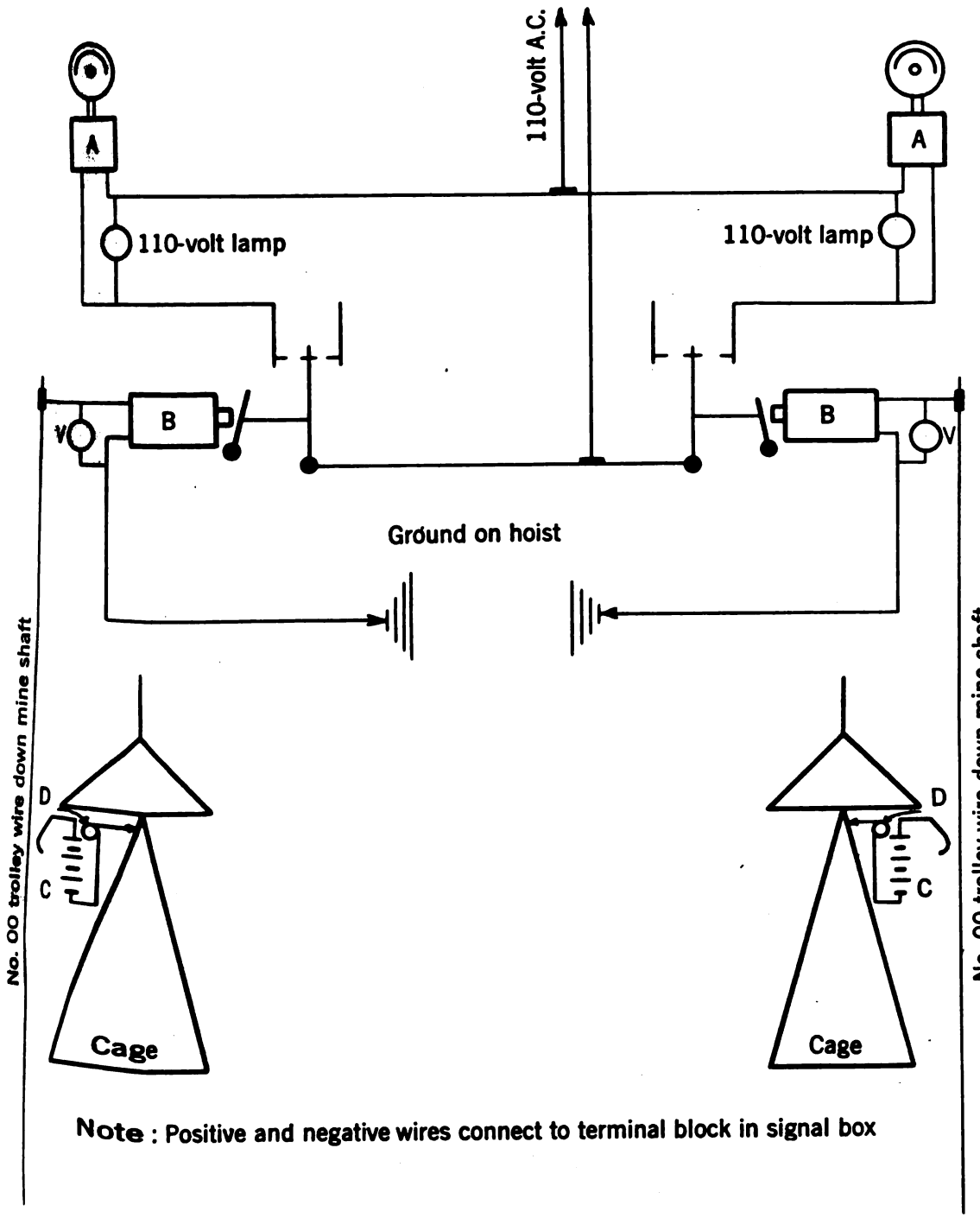

Figure 1.—Wiring chart for hoist signal system, Daly West and Daly Judge shafts, Park Utah Consolidated Mines Co. A, Signal Electric Co. single-stroke, 110-volt, a.c., 10-inch bells; B, Bonnell 150-ohm relays; C, 3-cell L-20 Edison batteries; D, cage switch; V, voltmeter.

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brushes is made through three fiber rings with brass inserts which are fastened to the switch shaft. As the shaft is rotated a movable curved galvanized-iron plate or pantograph attached to its end is forced in contact with the trolley wire. The pantograph does not remain in contact with the trolley wire except during signaling, but if contact should be made accidentally, the bell does not ring, as no contact is made through the rotary switch on the cage.

On one of the installations of the system a device is provided to keep a light above the bell turned on after the signal has been given until the cage is moved. The object of this arrangement is to eliminate the possibility of the engineer's mistaking a repeated signal for a signal from the skip in the other compartment of the shaft. The device consists of two magnetic switches, connected in series, and a drum directly connected to the shaft-hoist indicator. The drum, which is synchronized with the indicator, is fitted with fiber rings and brass inserts which make a contact with flexible brass fingers.

The cost of installing the system is $2,500 for each compartment and the maintenance is about $25 a month, including labor. The life of the battery is about 2 years. The system is checked daily by the electrician, the inspection requiring about 8 minutes. The storage battery is charged and watered every 2 weeks, the pantograph is replaced about once a month, and the trolley wire is cleaned annually. During the past 2 years of constant operation the only damage to the system due to falls of rock or other material was a broken pantograph.

Accurate data kept over a period of two years show this system to be cheaper in installation and upkeep than the level signaling formerly used; therefore it is not expensive, but it is not safe practice to have only one signaling method in any shaft. - - -

Some of the difficulties encountered during the experimental stages of the installation follow: At first, six dry-cell batteries were placed in a tube on the cage. Bumping of the cage on the level chairs caused the batteries to break in pieces. Three Edison L 20 storage batteries were substituted. A metal container of the proper size was made, and the cells were placed inside and kept firmly in place by pouring hot G. E. No. 227 cable compound around them. Small blocks of wood were placed under the cells to permit the flow of compound beneath the cells. This type of storage battery, containing the three Edison L 20 cells in series, has given excellent service. The metal container which holds the storage battery is provided with springs and cushion plates to absorb the shocks. Many of these storage batteries have a life ranging from 6 to 8 years.

Difficulty was experienced in ringing bells with the 6-volt circuit. A 150-ohm relay was installed in the hoist house, as shown in figure 1, and the bell was then operated by means of a 110-volt alternating current. Small voltmeters were placed on the 6-volt lines. These voltmeters are in direct view of the hoistman and operate each time the circuit is completed by the pantograph. They serve both as an indicator of the bells rung in case anything happens to the relay or the 110-volt alternating-current circuit and also as an indicator of any

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voltage drop in the shaft circuit. It has been found that weekly inspection by the electrician are ample.

Pantographs were first made of aluminum. This did not prove satisfactor and pantographs are now made of 18-gage galvanized iron, heavily tinned to prevent rusting.

Rust, which formed on the clevis pin connecting the cage to the cable, would cause too great a resistance to the ground from the battery. This cou be quickly washed out with a hose, but it was found advisable to overcome th resistance by a bond of heavy copper cable placed between the main cable cla and the cage.

Upon failure to receive the correct signals, the hoisting engineer uses push-button switch which is on the level call system. This causes buzzers t sound on the levels at one of the installations. At the other installation, lamps that flash are used instead of buzzers. The signal is then repeated b the man on the cage.

Types of hoisting cable seem to have very little effect on the ground fr the storage batteries, as 1-inch round cable is used at the Daly West shaft 3/8- by 5-inch flat cable in the Daly Judge shaft.

Figure 1 is the wiring chart for the hoist-signal system at the Daly Wes and Daly Judge shafts; this chart is the same as figure 1, Information Circul 6161, with the addition of a light above the bell and a voltmeter in the 6 volt direct-current circuit.

Figures 1 to 8, inclusive, are the working sketches for construction of cage pull-switch-pantograph device. As the cold-rolled steel shafting in th signal boxes wears considerably, a slot should be cut in the side of the bo to permit its removal. The shaft, shown on figure 6, may be threaded for a longer distance on the ends, a lock nut can be used in place of the collar (in figure 2), and two lock nuts can be used on the end of the shaft. This later type of shaft has been used on some of the more recent installations. A hole may be drilled through the shaft (fig. 6) instead of using the 2-1/2- inch key slot. It is suggested that the life of the shaft could be lengthen by replacing the bearings (2, fig. 2) with ball bearings.

Figure 9 shows the cage assembly.

Figure 10 shows the storage-battery case assembly. Eric Neilson, master mechanic of the Park Utah Consolidated Co., estimates that the complete assembly of the material needed to equip one cage can be made at the present time in a good mine shop for about $100. Maintenance costs are estimated to be around $10 a month for each shaft.

Figure 11 shows the wiring plan for the cage bell system used at the Dal Judge shaft. The signal lamps remain lighted until the hoist is set in moti This not only identifies the compartment from which the signal was rung but also permits the hoistman to know whether a signal was rung during his absen from the hoist house.

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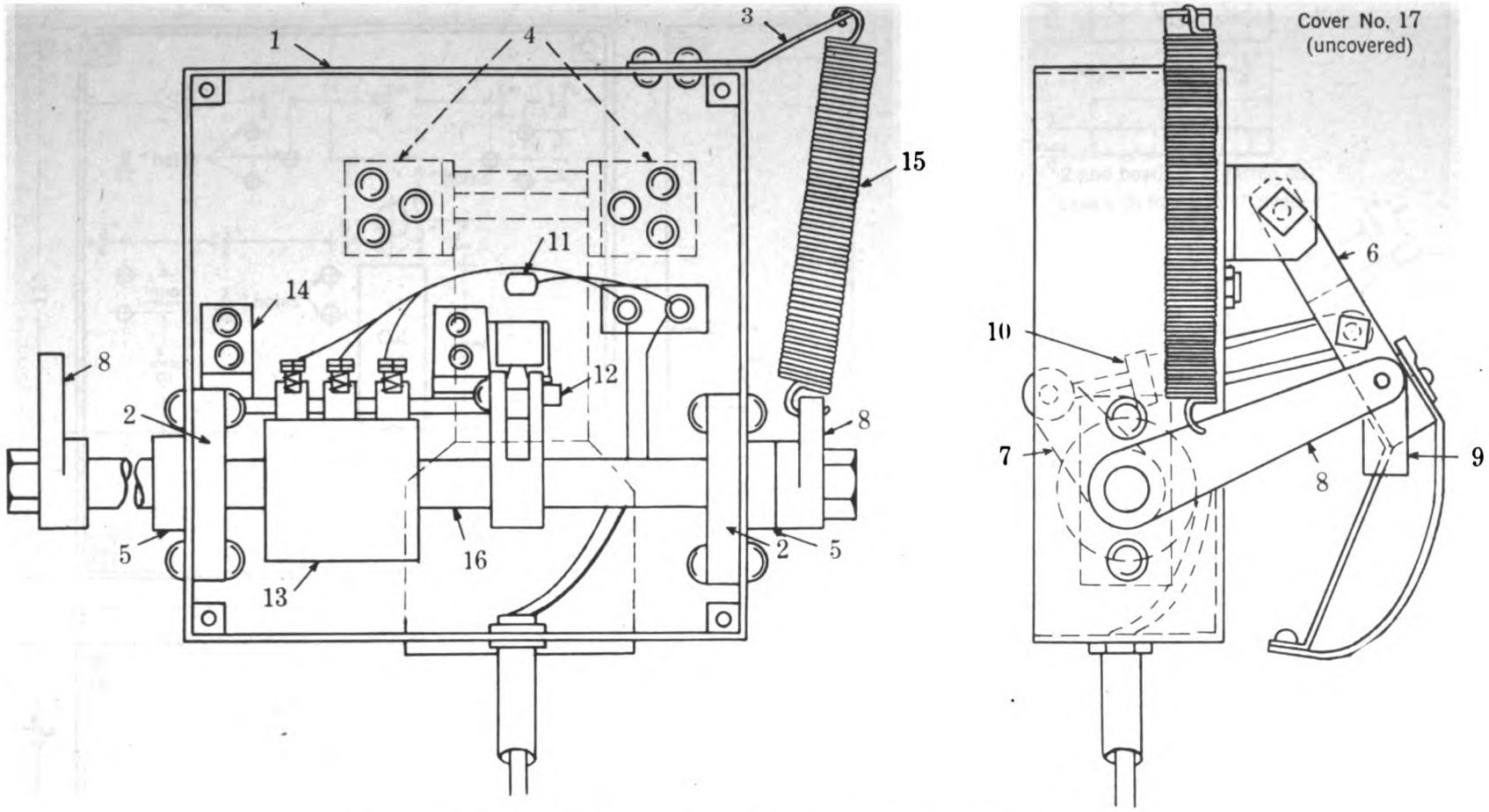

Figure 2.—Assembly of mine-hoist signal case (cover removed).

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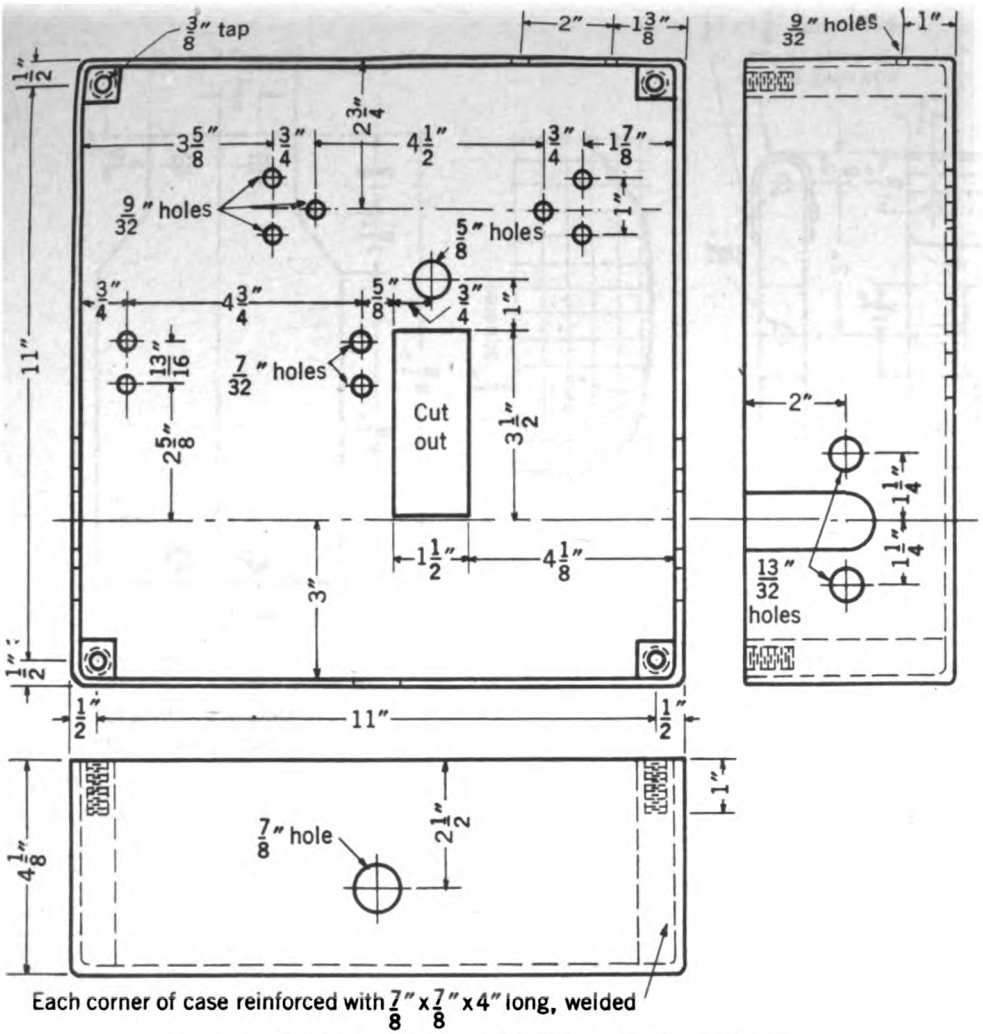
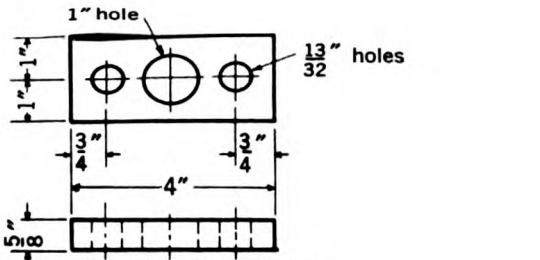


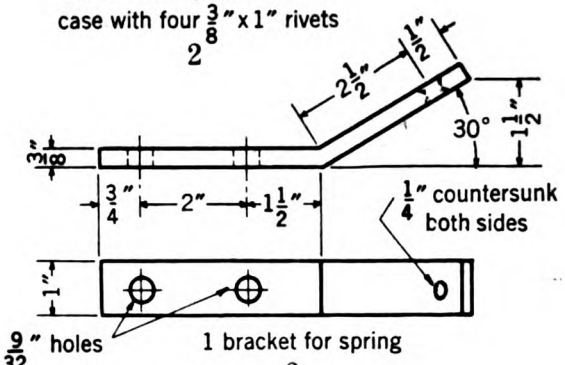
1 case of No. 9 gage steel plate; all joints acetylene-welded

1



2 end bearings to fasten on case with four 3/8" x 1" rivets

2



1 bracket for spring

3

Figure 3.

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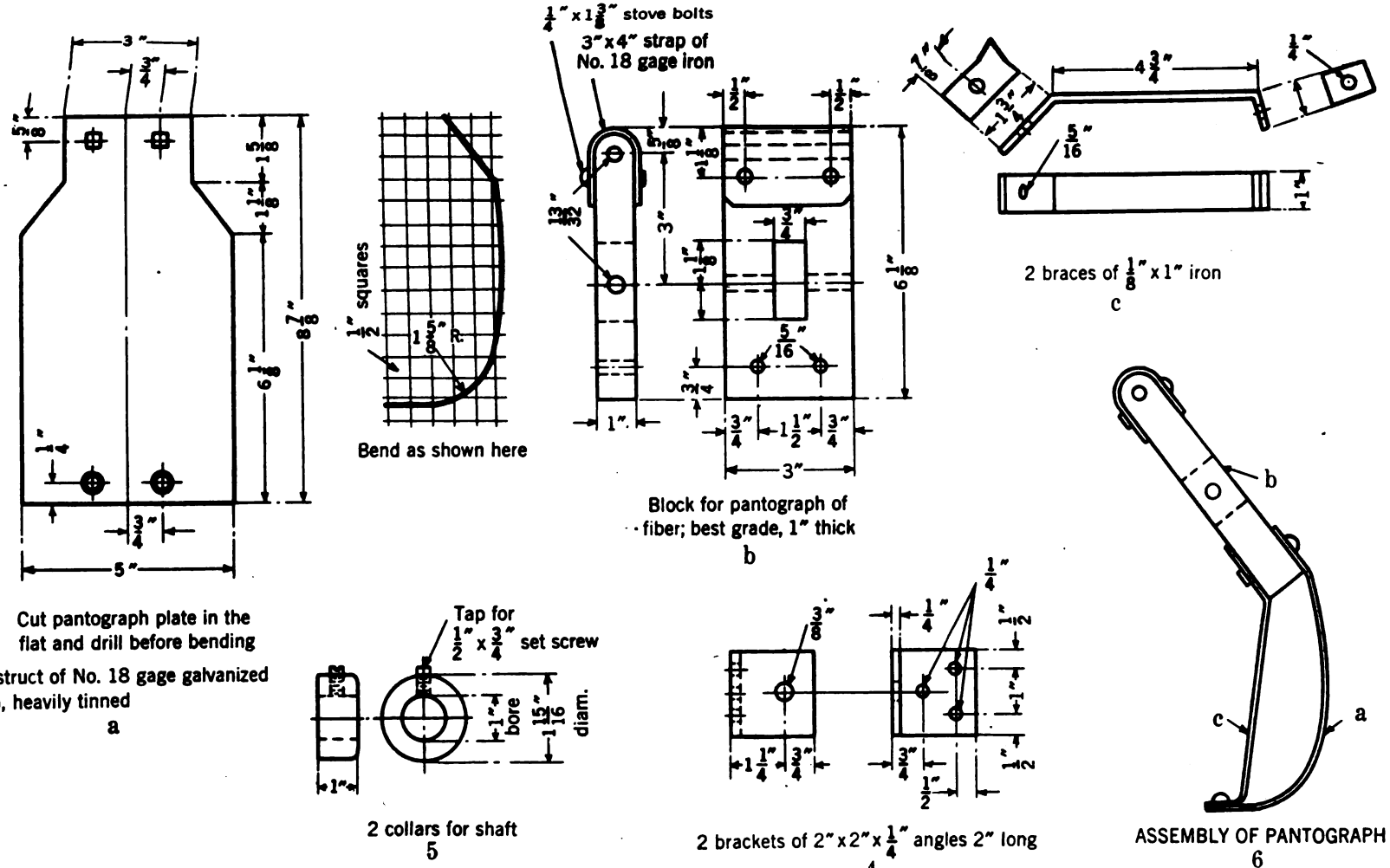
Cut pantograph plate in the flat and drill before bending
Construct of No. 18 gage galvanized iron, heavily tinned
a
Bend as shown here
1/4" x 1 3/8" stove bolts
3" x 4" strap of No. 18 gage iron
Block for pantograph of fiber; best grade, 1" thick
b
2 braces of 1/8" x 1" iron
c
Tap for 1/2" x 3/4" set screw
2 collars for shaft
5
2 brackets of 2" x 2" x 1/4" angles 2" long
4
ASSEMBLY OF PANTOGRAPH
6

Figure 4.

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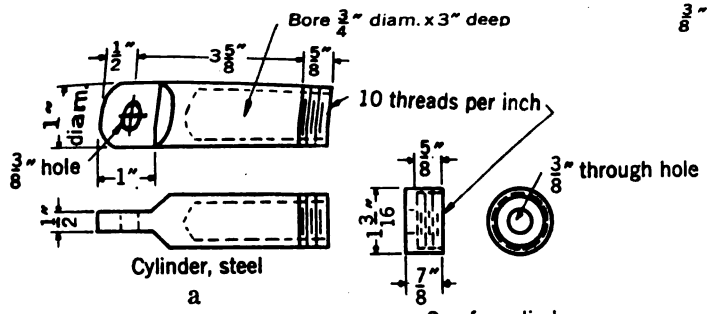

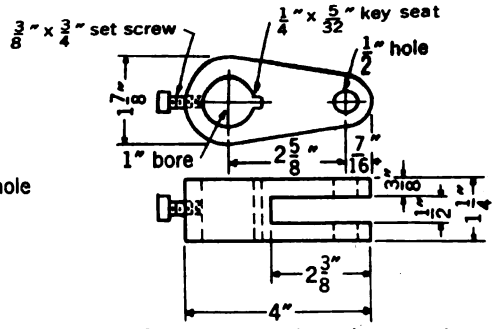

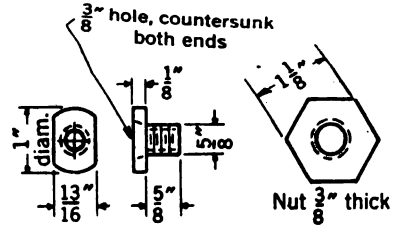

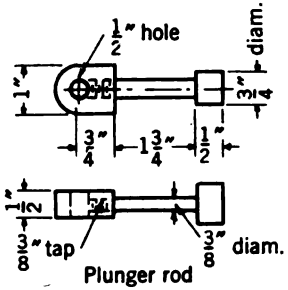

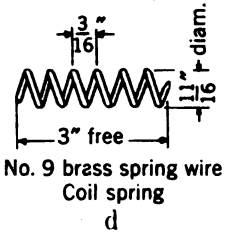

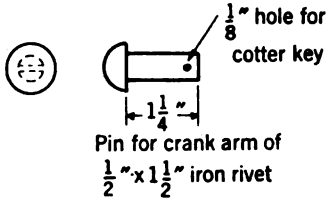

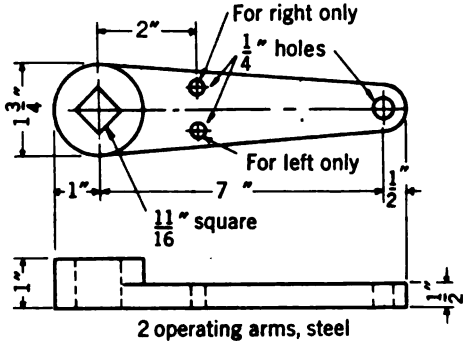

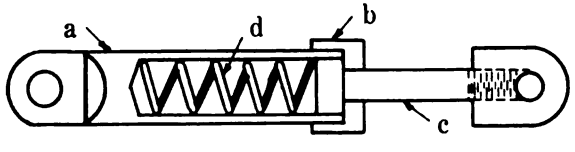

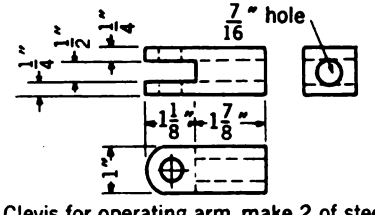

Figure 5.

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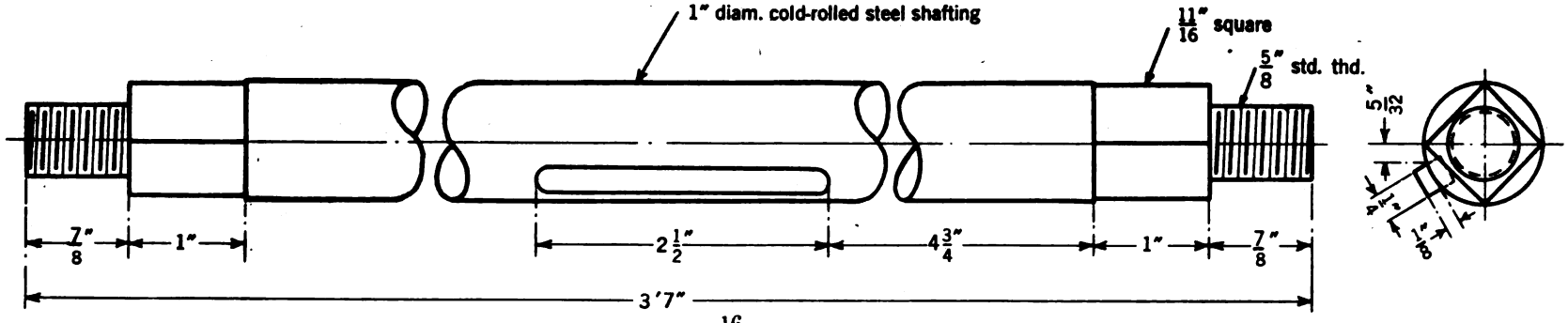

Figure 6.—Shaft for signal boxes used at Judge shaft, shaft 3'7" long, for Daly West signal boxes and key placed on right end of shaft. Same dimensions starting from right. Keys to be fit in shaft tight ¼" wide 2½" long. Projection above shaft 1/8". Placing of key at proper angle as shown is very important and should be worked out with care, to insure perfect alinement of all working parts. Furnish with each shaft 2-5/8" spring washers and 2-5/8" hex. nuts.

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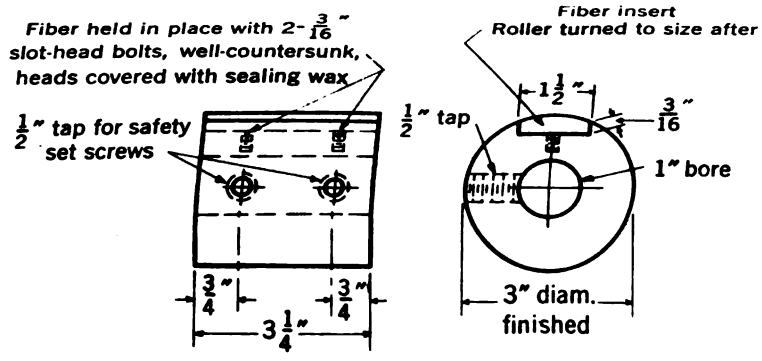
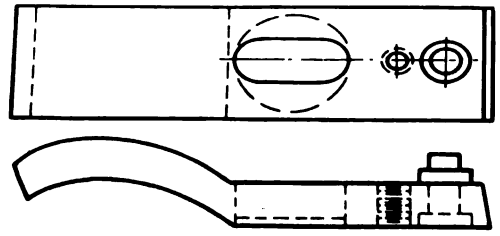


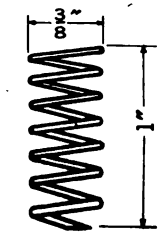
Contact roller of bronze and fiber

13



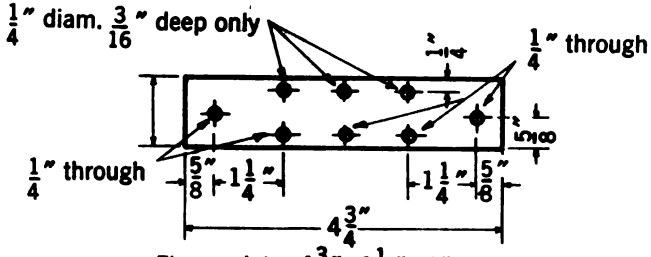
3 contact fingers, used in this signal system are the same as for CR 7006 D3 magnetic switch cat. No. 1773087 G3. Fingers held in place with 3 No. 8-32 brass bolts 1 1/2" long, with hex nuts

c



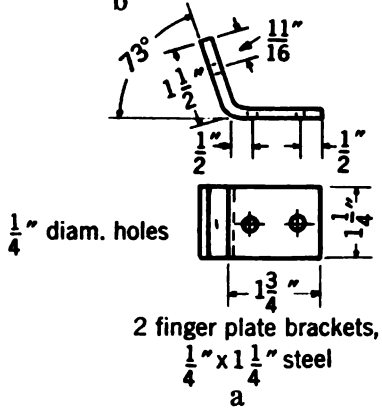
3 brass springs for contact fingers No. 16 gage wire

d



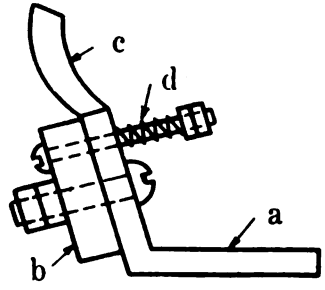
Finger plate of 3/8" x 1 1/4" x 6" steel

b



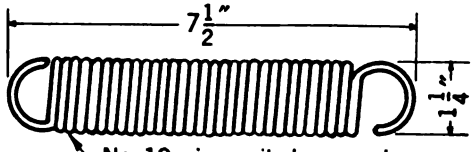
2 finger plate brackets, 1/4" x 1 1/4" steel

a



End view assembly of finger rack

14



No. 10 wire, coil close as shown

Steel spring

15

Figure 7.

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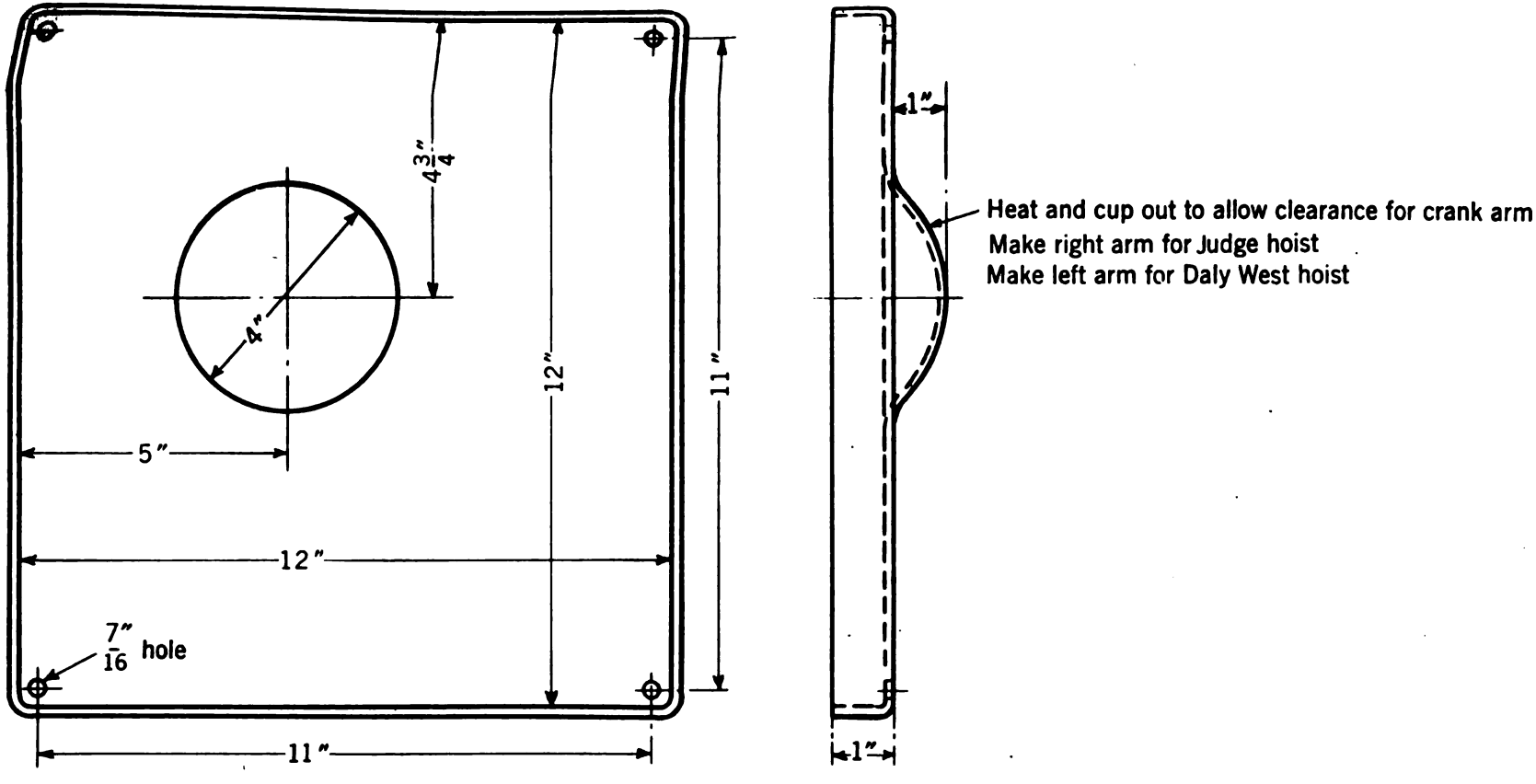

1 cover for case of No. 9 gage steel plate

Figure 8.

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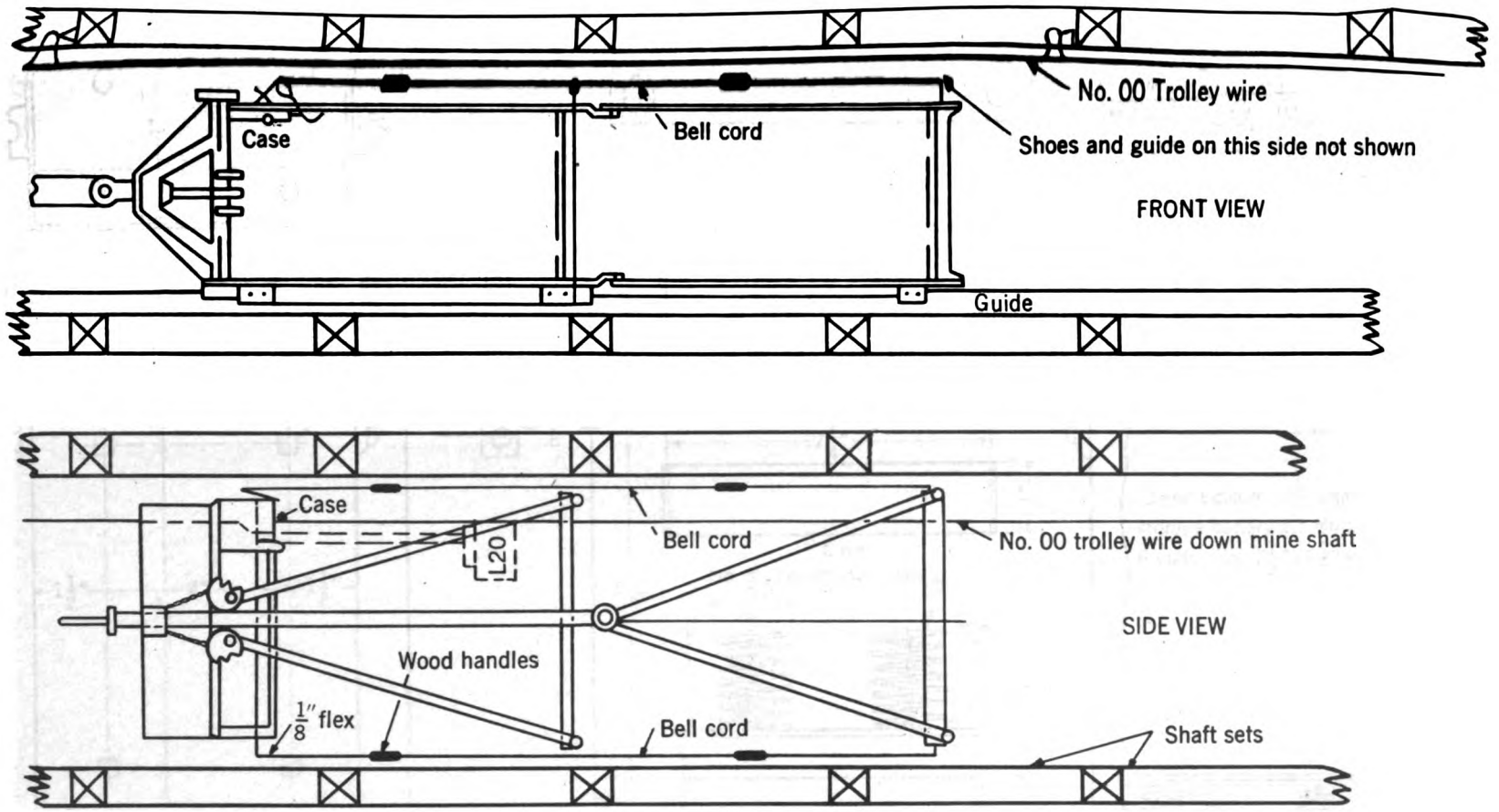

Figure 9.—Cage with "Jimsco" hoist signal system attached. When used as shown here, the shaft on the signal must be long enough to extend across cage so as to have bell cord on either side.

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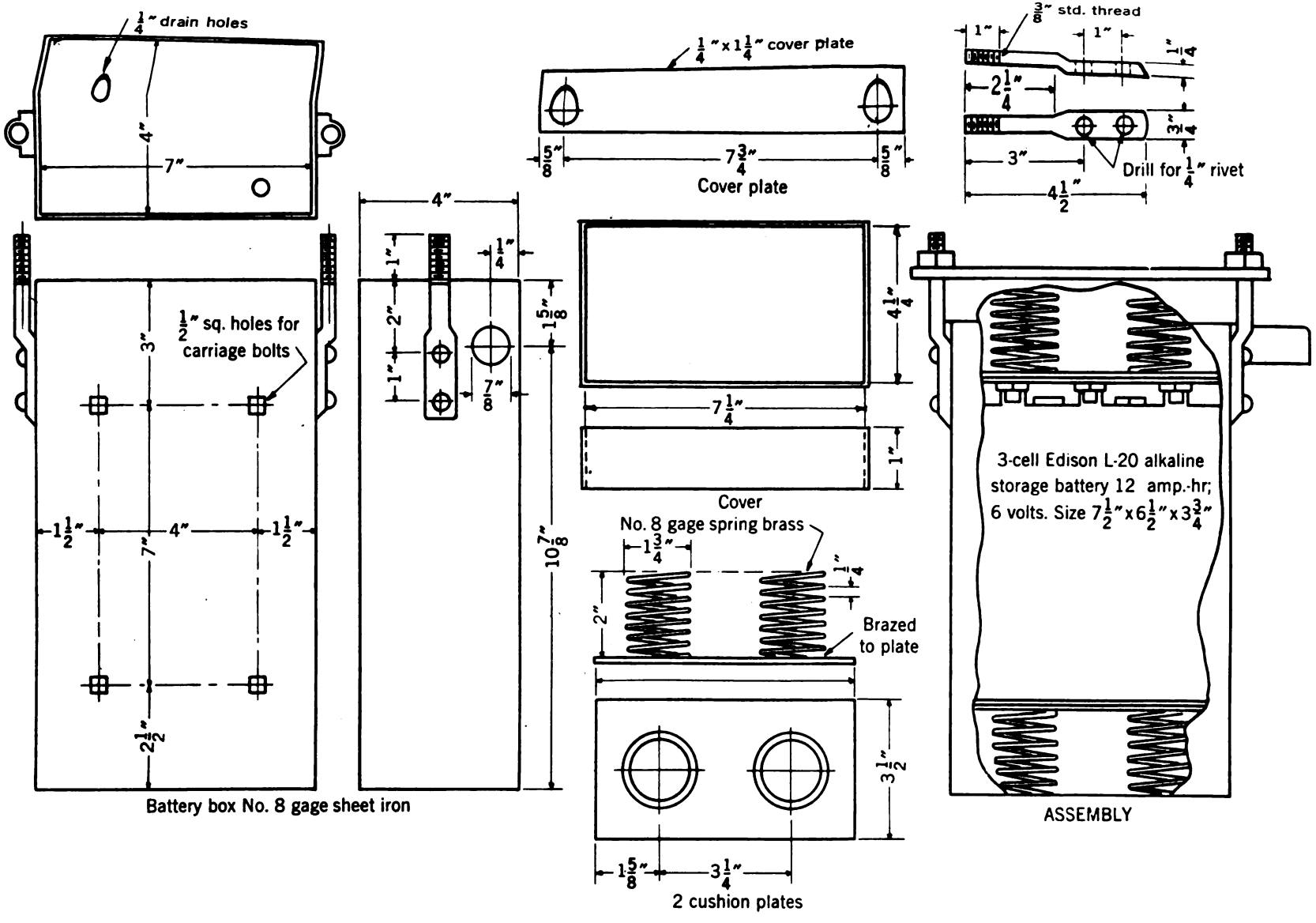

Figure 10.

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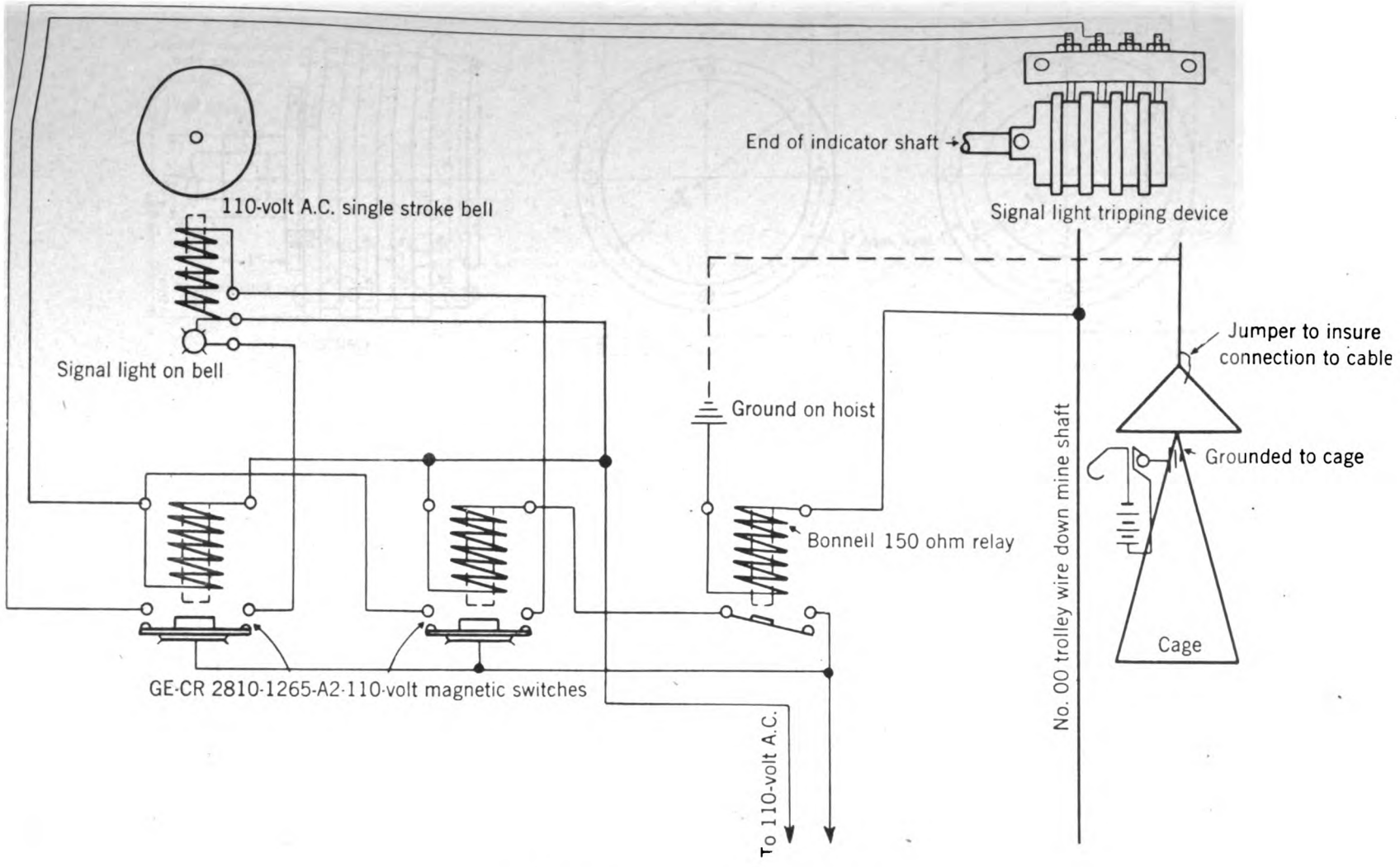
End of indicator shaft
Signal light tripping device
110-volt A.C. single stroke bell
Signal light on bell
Ground on hoist
Jumper to insure connection to cable
Grounded to cage
Bonnell 150 ohm relay
No. 00 trolley wire down mine shaft
Cage
GE-CR 2810-1265-A2-110-volt magnetic switches
To 110-volt A.C.

Figure 11.—Wiring plan of cage bells.

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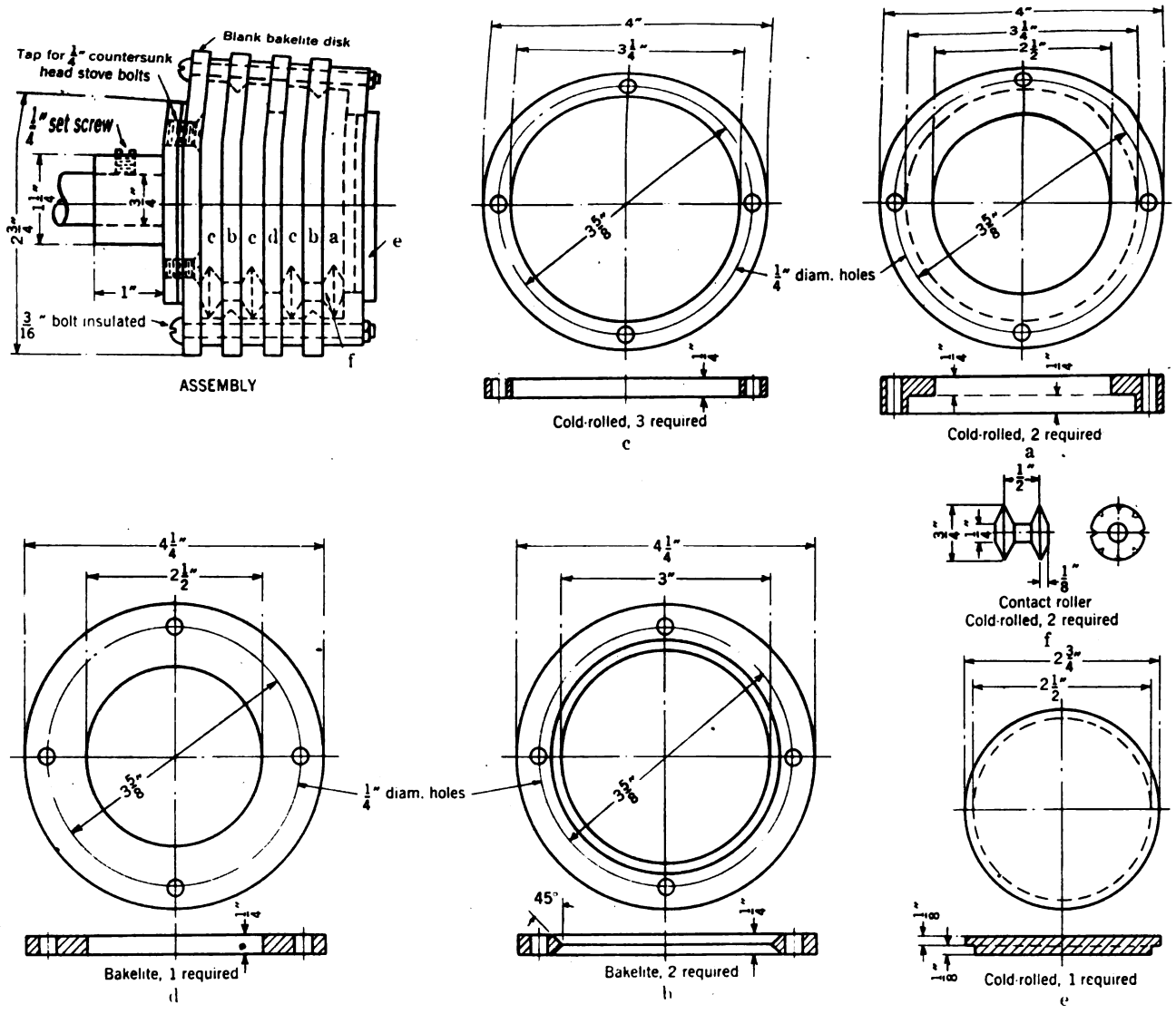

Figure 12.—Tripping device.

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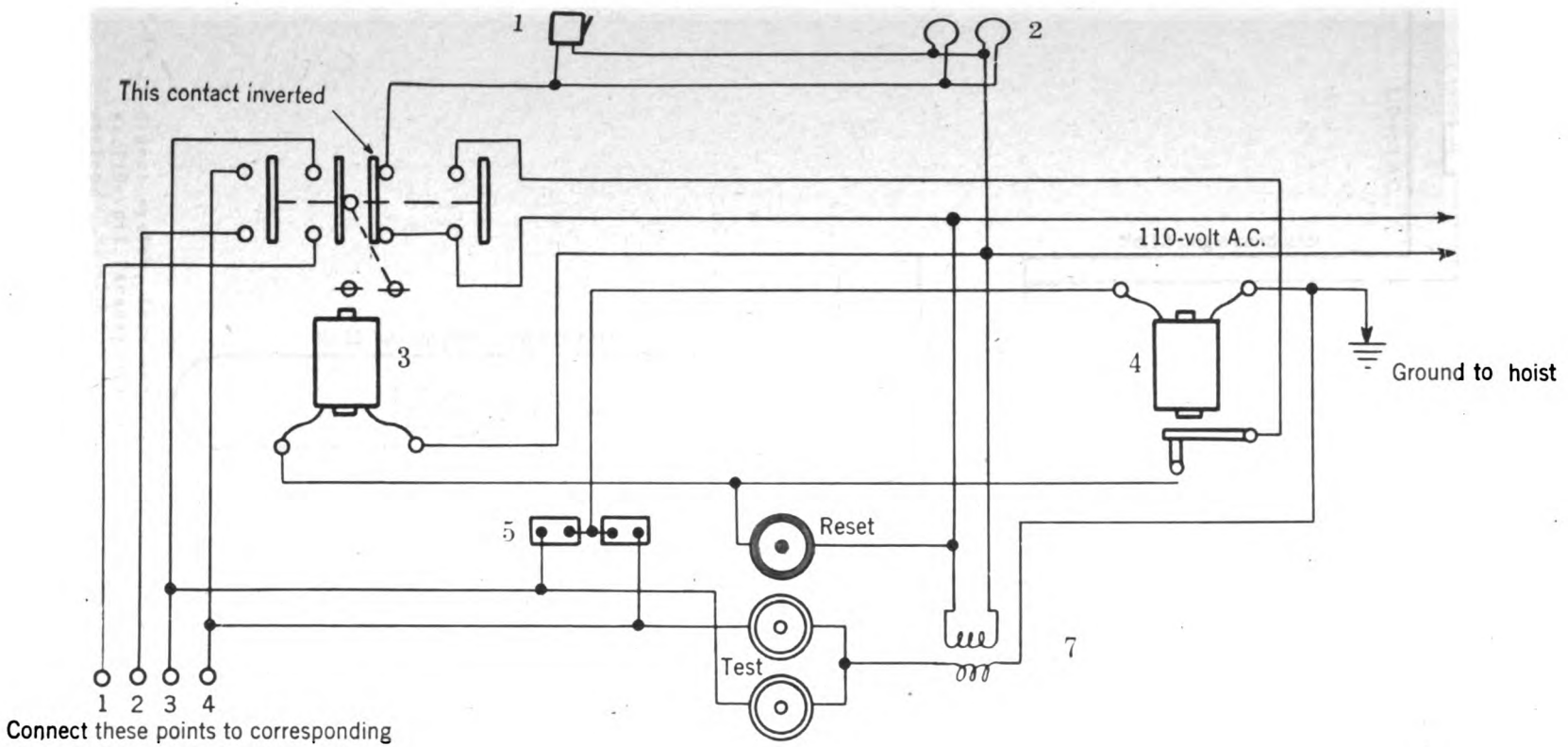

Legend

1-Benjamin 110-volt buzzer
2-110-volt, 200-watt lamps
3-GE-D26-110-volt magnetic switch
4-Bonnell-150-ohm relay
5-2-mfd. condensers
6-GE-68245 push buttons
7-GE-110/12-volt bell transformer

Figure 13.—Automatic disconnect and indicator of false bells, caused by tramp current in mine.

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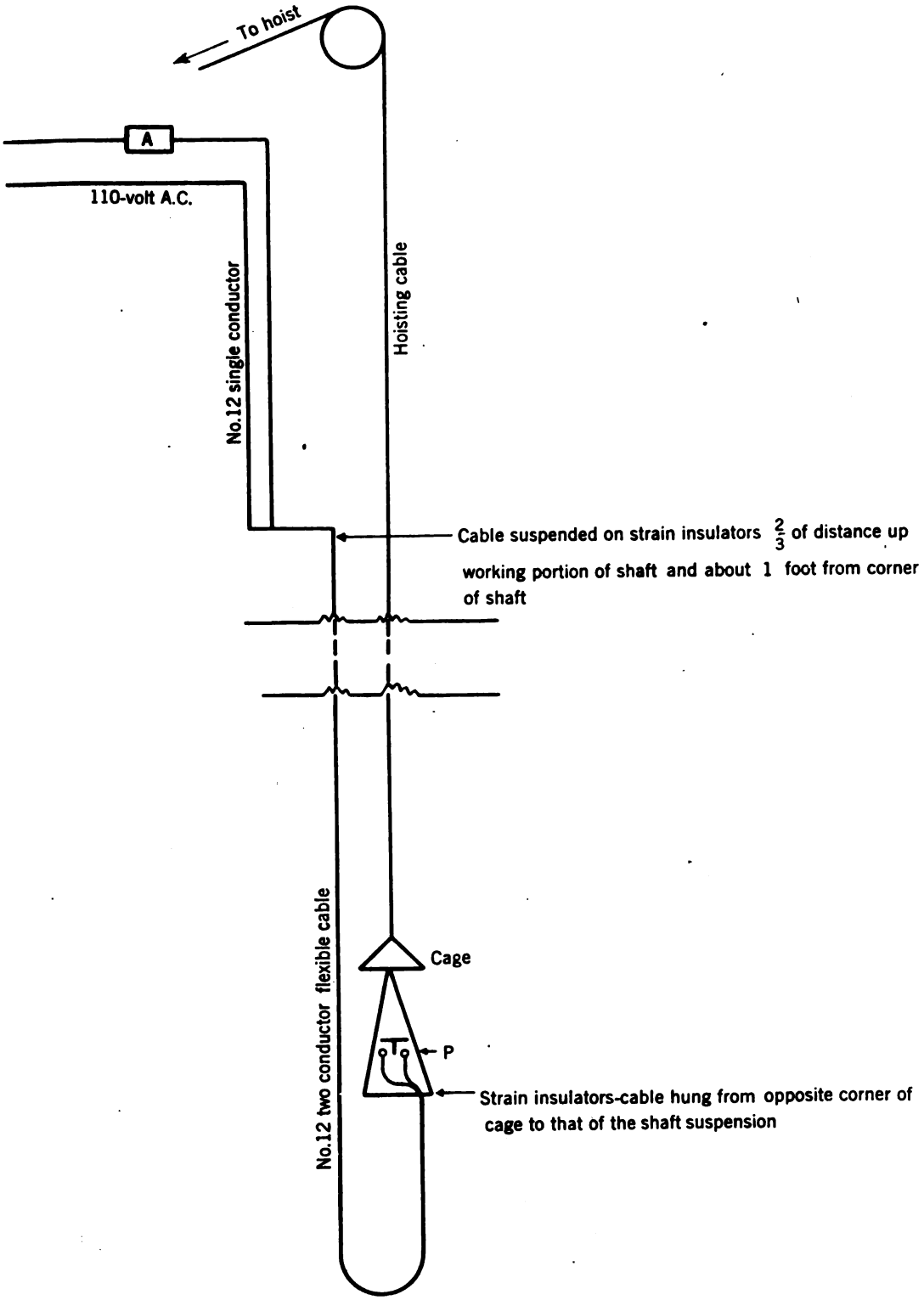
To hoist
A
110-volt A.C.
No.12 single conductor
Hoisting cable
Cable suspended on strain insulators 2/3 of distance up working portion of shaft and about 1 foot from corner of shaft
No.12 two conductor flexible cable
Cage
P
Strain insulators-cable hung from opposite corner of cage to that of the shaft suspension

Figure 14.—Signal system, Star and Ontario shafts, Park Utah Consolidated Mines Co., A, 110-volt Faraday vibrator; P, Crouse-Hinds pull switch with 25-pound spring.

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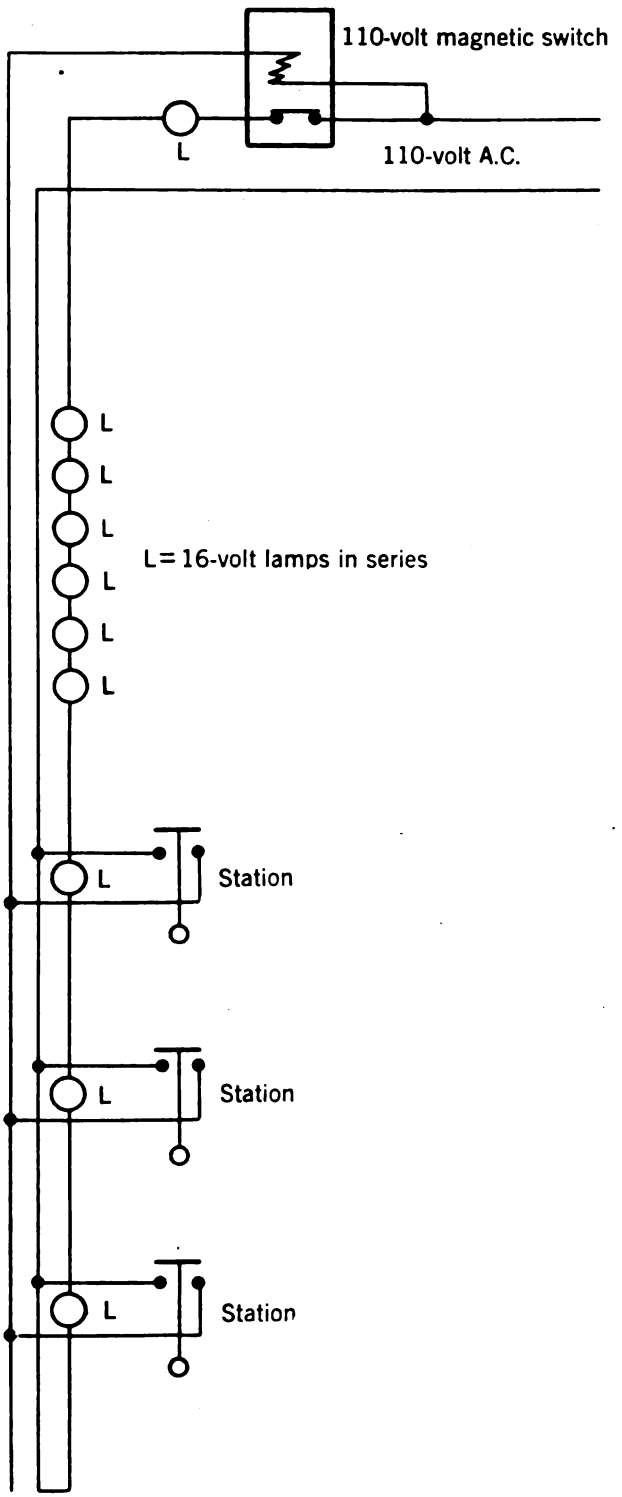

Figure 15.—Level call system used in the Star and Ontario shafts, Park Utah Consolidated Mines Co.

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Figure 12 shows the assembly of the tripping device for the signal light. The steel contact roller is notched as shown. This can be done with a file.

Figure 13 shows the wiring plant for the detection of false bells. False bells have been caused by a slight leakage from high-voltage cables, especially when passing through very wet places in the shaft. False bells have been of little consequence in the Park Utah installation, and the installation of this addition to the system is, in general, optional.

A very simple and effective system for signaling from cages is used by the Park Utah Consolidated Mines Co. in its Star and Ontario shafts. Operations in these shafts are restricted to a vertical range of 300 to 500 feet. The signal cable is suspended in a manner somewhat similar to that used on an elevator.

No. 12 two-conductor rubber-covered cable with an outside diameter of about 9/16 inch is used. This cable is suspended by strain insulators from a point about two-thirds of the length of the working portion of the shaft above the lowest working level and about 1 foot from a corner of the shaft, to a point on the opposite corner of the bottom of the cage. The cable is carefully freed from all twists, and the cable should be just long enough to allow free suspension of the loop below the cage when the cage is at its lowest position.

The mechanism on the cage is first assembled in the mine shop on a piece of 1/4-inch steel plate. The complete assembly is then bolted through the guide shoe to the inside of the cage with 3/4-inch plow bolts and consists of the following: A Crouse-Hinds pull switch with a 25-pound spring is fastened onto the steel plate. The pull switch is operated by means of a lever made from a 30-inch piece of 1/2-inch pipe. The pipe is held horizontally by two stirrup brackets, about 12 inches apart and is supported from its center by the cord from the pull switch. In its normal position the pipe just touches the top of both brackets. When either end of the pipe is pulled down, the opposite bracket acts as a fulcrum, and the pull switch is operated. The pipe is long enough to permit signaling while a man is standing outside of the shaft on level stations. The wiring is continued from the upper end of the suspended cable to the hoist house where a 110-volt Faraday vibrator sounds the signals for the hoist man. The circuit is energized with 110-volt alternating current.

Figure 14 shows the signal system and figure 15 the level-call system in these last two shafts.

Both systems described have proved very effective and have given a minimum amount of trouble during 19 years of continuous service.

Appreciation is expressed for the cooperation given by P. H. Hunt, manager of mines, Park Utah Consolidated Mines Co., and his associates.

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